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(71) Applicant *(for all designated States except US)*: OXFORD INTELLIGENT MACHINES LTD. [GB/GB]; 12 Kings Meadow, Ferry Hinksey Road, Osney Mead Industrial Estate, Oxford OX2 0DP (GB).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: JONES, Timothy, John [GB/GB]; West Spring, Northside, Steeple Aston, Bicester OX6 3SE (GB).

(74) Agent: VALENTINE, Francis, Anthony, Brinsley; Reddie & Grose, 16 Theobalds Road, London WC1X 8PL (GB).

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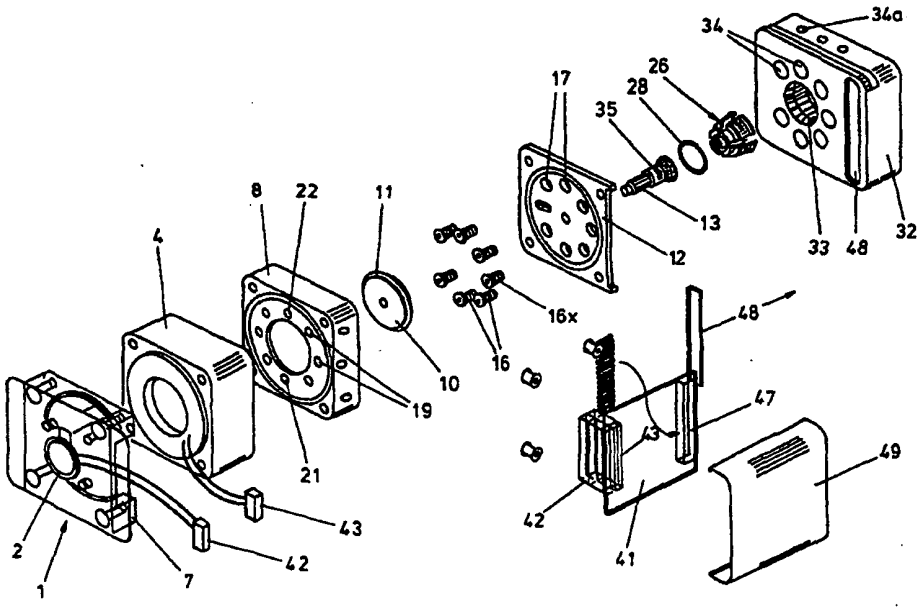

(57) Abstract

Tools to be mounted on a robot arm are each fixed on a tool carrier member (32) having fluid pressure connector bores (34) and electrical connectors (48) to register respectively with fluid pressure connectors (16) and electrical connectors (47) on a base assembly (1, 4, 8, 12) mounted on the robot arm which carries a single fluid pressure supply. Solenoid operated valves in a valve block (8) in the base assembly selectively connect each connector (16) to the supply or exhaust and also operate an actuator to engage or disengage a collet (26) projecting into a bore (33) in the tool holder (32) to hold or release the latter.

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Interchangeable Tool Holder Assemblies

This invention relates to interchangeable tool holder assemblies whereby one tool assembly having fluid pressure and/or electrical supply connections can be rapidly removed from a supporting base assembly and rapidly and reliably replaced by another tool holder assembly. The base assembly may for example be carried by a robot arm.

In one known arrangement, the base assembly includes a plate carrying an array of pneumatic connector halves and each tool assembly has a mounting plate with a corresponding array of pneumatic connector halves for mating with those on the base assembly and a pneumatically-engaged locking device, resiliently biased to its disengaged state, for securing the plate of the tool carrier to the plate of the base assembly.

In an assembly according to one aspect of the present invention, each tool assembly has a shaped bore to receive an expansible collet carried by the base assembly and having a central operating rod connected to a fluid pressure operated actuator for selectively expanding the collet to engage locking surfaces on the collet with locking surface portion of the shaped bore, and contracting the collet to permit removal of the tool carrier. Preferably the actuator is double-acting and has sufficient internal friction to retain the rod in its existing position if the supply of fluid pressure fails, thereby ensuring that the tool holder assembly does not fall from the base assembly.

In an assembly according to the invention in another of its aspects, the base plate and tool holder plate have a plurality

of the fluid pressure connectors, and the base assembly has a single supply conduit serving more than one of the said connectors by way of respective solenoid valves controlled by electrical signals from a central controller. This arrangement reduces the number of fluid conduits required to lead up to the base assembly of the tool holder assembly - typically only one supply conduit is necessary (with one return conduit if required).

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal sectional view through the connection between a tool holder assembly and a base assembly, for example at the end of a robot arm;

Figure 2 is a longitudinal sectional view on the line II-II of figure 1;

Figure 3 is an exploded view of the components of the assembly shown in figures 1 and 2;

Figure 4 shows a portion of figure 1 on an enlarged scale;

Figure 5 is a perspective view of a collet jaw; and

Figure 6 shows a mounting arrangement for a tool holder when not in use.

The tool holder assembly shown in the drawings is mounted on the end of a robot arm (not shown) by means of a robot interface plate (1) having a central socket (2) to receive the end of the

hollow robot arm and to form a continuation (3) of a duct therein for electrical cables. Secured to the end face of the interface plate (1) is a solenoid valve block (4) which houses eight conventional three-port solenoid operated pneumatic valves each having its supply port connected to a single common supply (7). Secured against the front face of the valve block (4) is a cylinder block (8), the central part of which forms a cylinder (9) within which is slidable a short-stroke piston (10) having a peripheral groove containing an O-ring (11). The cylinder (9) is closed by a front plate (12) formed with a central bore through which passes a piston rod (13) secured at its rear end to the piston (10), the bore having a groove accommodating an O-ring (14) which makes sliding sealing contact with the piston rod (13). The front plate (12) of the base assembly also has a set of seven apertures (15) ranged at intervals of 45° on a circle, the rear end of each bore (15) being counter-bored to a larger diameter. Each bore (15) thus retains a pneumatic connector element (16) having a rear flange (17) received in the counter-bore and having on it projecting forward end a groove receiving an O-ring (18).

The cylinder block (8) is formed with six through-passages (19) (Fig. 1) aligned with six of the connectors (16) to connect the latter to respective solenoid valves in the valve block (4). Thus each connector (16) can be selectively connected to the supply (7) or to exhaust by its respective solenoid-valve. The seventh connector (16X), which is diametrically opposite the position where there is no connector (16), prevents a tool carrier plate from being connected to the base assembly in the wrong angular position.

The cylinder block (8) has two further passages (21, 22) which

connect the opposite ends of the cylinder (9), on opposite sides of the piston (10) to the remaining two solenoid-operated valves in the valve block (4).

The forward end of the piston rod (13) has an enlarged head (25) and carries a collet assembly (26) consisting in this example of four collet jaws (27) which are resiliently held together by a garter spring (28) in the form of an O-ring located in grooves in the outer surfaces of the collet jaws (27). Each collet jaw (27) has at its rear end an arcuate projection (29) which is received in an groove (30) in a boss (31) on the front plate (12). With this arrangement, the collet jaws are held loosely captive.

Each operating tool assembly to be carried in turn by the robot is mounted on a tool carrier plate (32) which has a central bore (33) capable of fitting over the collet assembly (26) and piston rod head (25) (when the piston (10) is in its forward position) and over the boss (31). Each tool carrier plate (32) also has a set of six sockets (34) to receive and make sealing contact with the pneumatic connectors (16) and their O-rings (18) (and a further socket (34X) to receive the dummy connector (16X)). These sockets (or lateral openings (34a)) are connected by suitable conduits (not shown) to the operating tool mechanisms carried by the plate (32).

To lock the tool carrier plate (32) to the base assembly, the passage (22) is pressurised to move the piston (10) and piston rod (13) rearwardly. A frusto-conical surface (35) on the piston rod head (25), as the head (25) moves rearwardly, expands the collet jaws (25) into contact with the wall of the bore (33) in the tool carrier plate (32) and in particular brings an

annular ridge (36) into locking engagement in a corresponding groove (37) in the bore wall (33). Even if the supply of air under pressure in the passage (22) fails, the friction caused by the O-rings (11) and (14) will retain the piston (10) and thus the head (25) in the position shown in the lower part of figure 4 so that the tool carrier plate (32) and the equipment mounted thereon cannot accidently fall off the base assembly. To release the carrier plate (32) for replacement by another such carrier plate, the two relevant valves in the valve block (4) are operated so as to connect the passage (22) to exhaust and to connect the passage (21) to the supply of air under pressure so that the piston (10) is moved forwards to the position shown in the upper part of figure 4 where the frusto-conical surface has moved forwards of the collet jaws (25) and the latter are disengaged from the locking groove (37) by the O-ring (28). As can be seen in figure 5, the angular extent of the base portion carrying the ridge (29) of each collet jaw is slightly greater than that of the forward part of the collet jaw.

Each tool carrier plate (32) has grooves (38) formed in a pair of opposite surfaces. These enable the tool carrier plates which are not in use to be securely retained in a tool holder (39) (figure 6) consisting of a plate (40) with a central cut-out (41), the sides (42) of which slidingly receive the grooves (38).

As can be seen in figures 2 and 3, a printed circuit board (41) is mounted on the base assembly (blocks 1, 4 and 8). This board carries a microprocessor (e.g. 8051), drive chips for operating the solenoid valves in the valve block (4), and connectors (42) and (43) for connection to the robot arm cable (44) and the

cables (45) for the solenoid valves. The board also includes an RS232 connector and straight through connectors for connection with a contact strip consisting of an array of gold plated sprung contacts (47) for making electrical contact for the corresponding contact strip (48) on the carrier plate (32) so that control signals may be sent to the operating tools carried by the latter and sensor outputs can be transmitted back to the microprocessor on the circuit board (41). The contacts on the board (48) may include a few dedicated contacts for the purpose of identifying to the microprocessor which tool carrier plate is mounted on the base assembly.

A cover plate (49) fits over the blocks (1, 4, 8) and protects the circuit board (41) and related components.

Claims

1. An interchangeable tool holder arrangement comprising a supporting base assembly including a base member (12), and a removable tool holder assembly including a tool holder member (32) constructed to fit against the base member (12), the base member (12) and tool holder member (32) having registering sets of fluid pressure and electric connectors (16, 47), and means (8,26,37) for releasably holding a tool holder member (32) against the base member (12), characterised in that the base member (12) and tool holder member (32) have a plurality of the fluid pressure connectors (16,34), and the base assembly has a single supply conduit (7) serving more than one of the said connectors by way of respective solenoid valves.

2. A tool holder arrangement according to claim 1, characterised in that the tool holder member has a shaped bore (33,37) to receive an expansible collet (26) carried by the base assembly and having a central operating rod (13) connected to a fluid pressure operated actuator (8,10) for selectively expanding the collet to engage locking surfaces (36) on the collet with locking surface portion (37) of the shaped bore, and contracting the collet to permit removal of the tool carrier.

3. A tool holder arrangement according to claim 2, characterised in that the actuator is double-acting and has sufficient internal friction to retain the rod in its existing position if the supply of fluid pressure fails, thereby ensuring that the tool holder assembly does not fall from the base assembly.

4. A tool holder arrangement according to claim 3, characterised in that the internal friction is generated by O-ring seals (11,12) on the rod (13) and/or a piston (10) of the actuator.

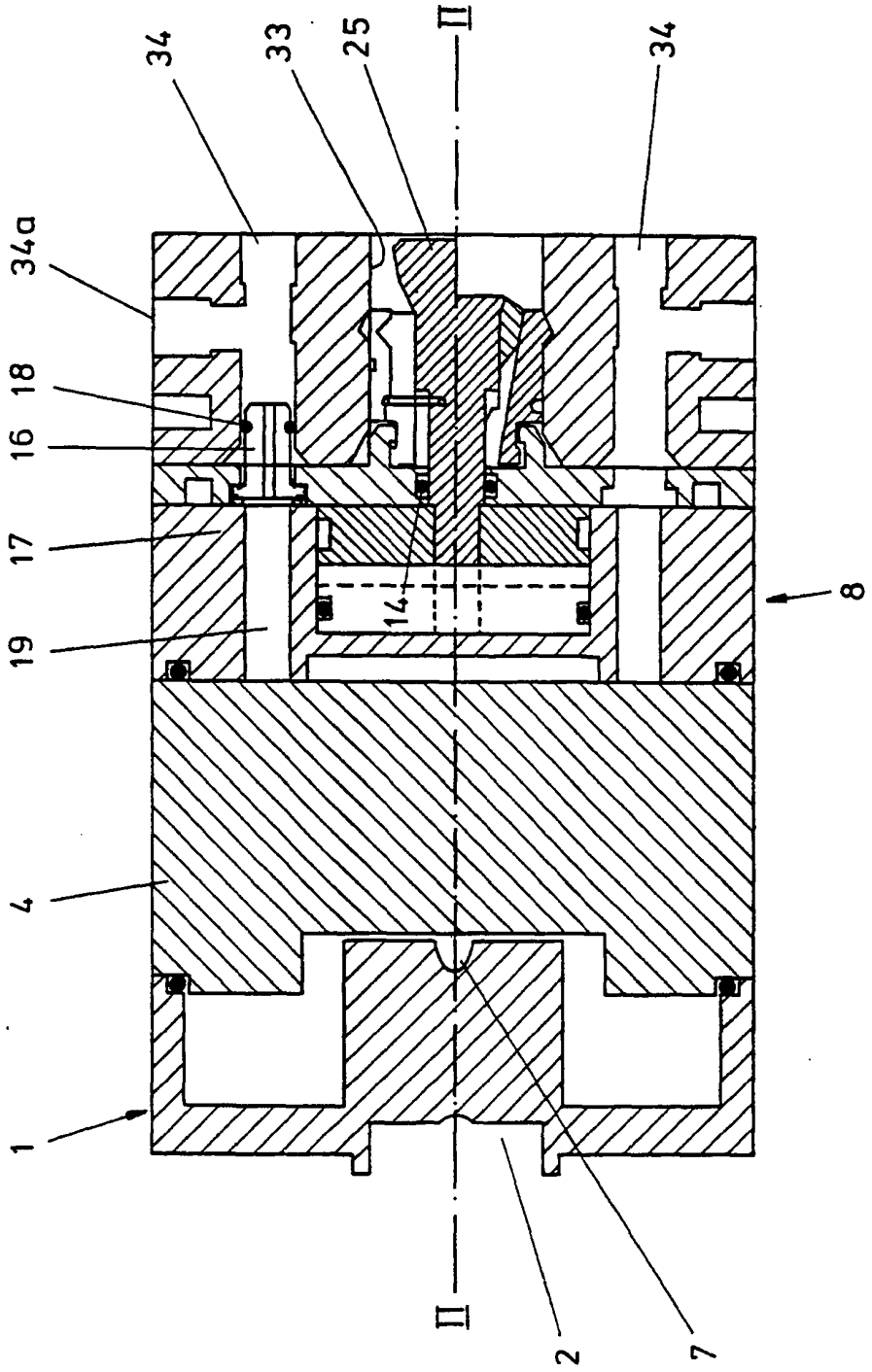
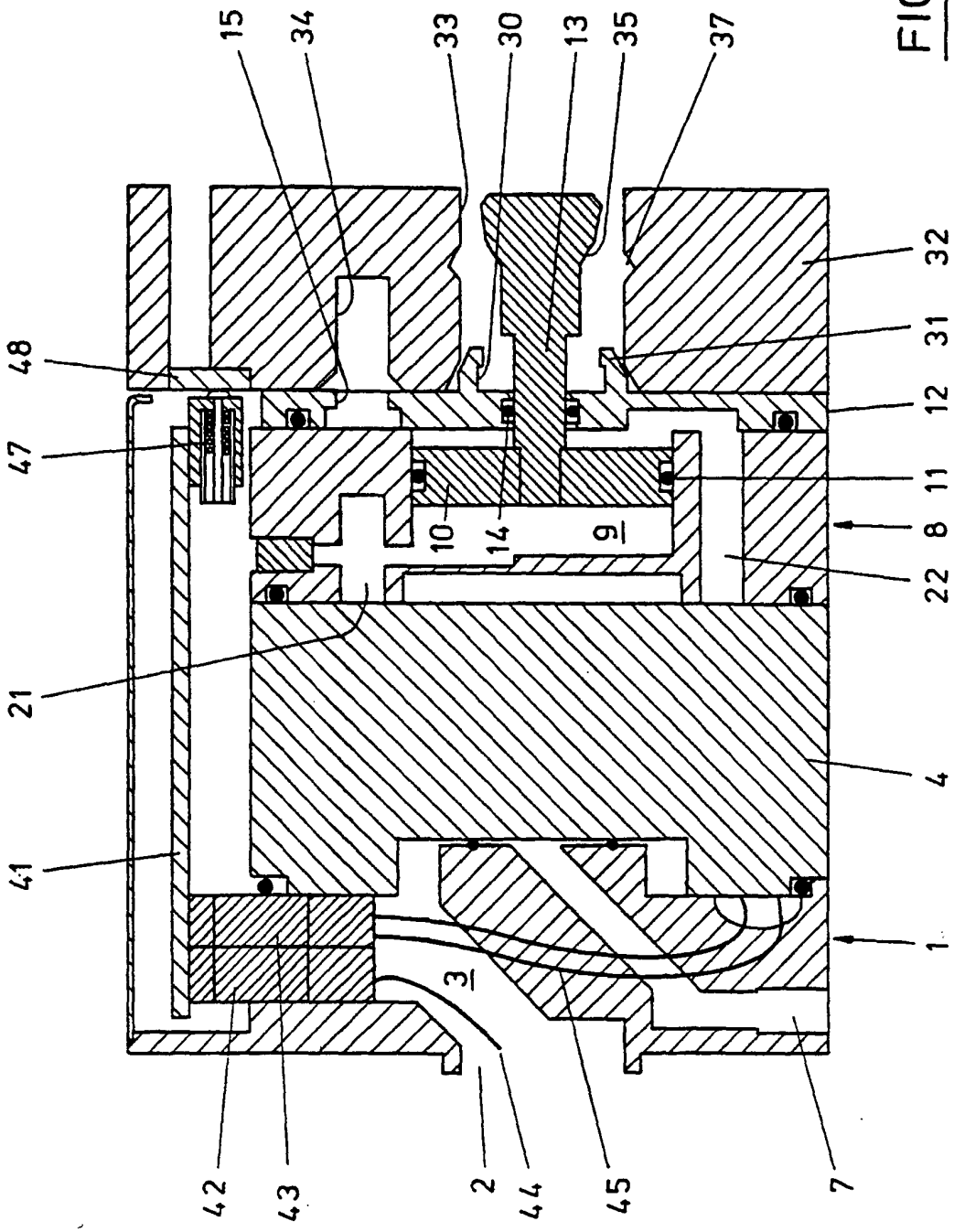


FIG. 1

FIG. 2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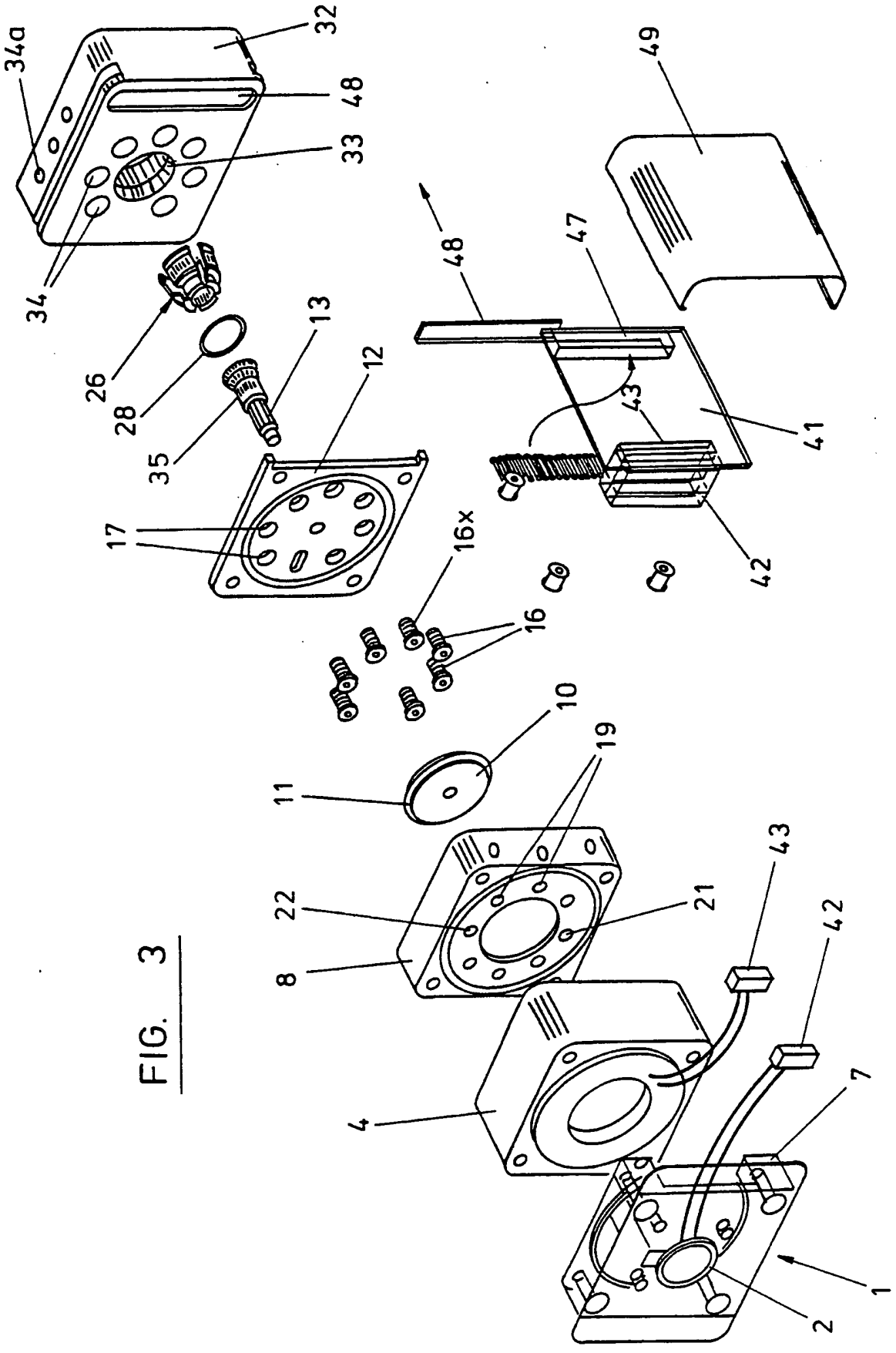
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FIG. 3

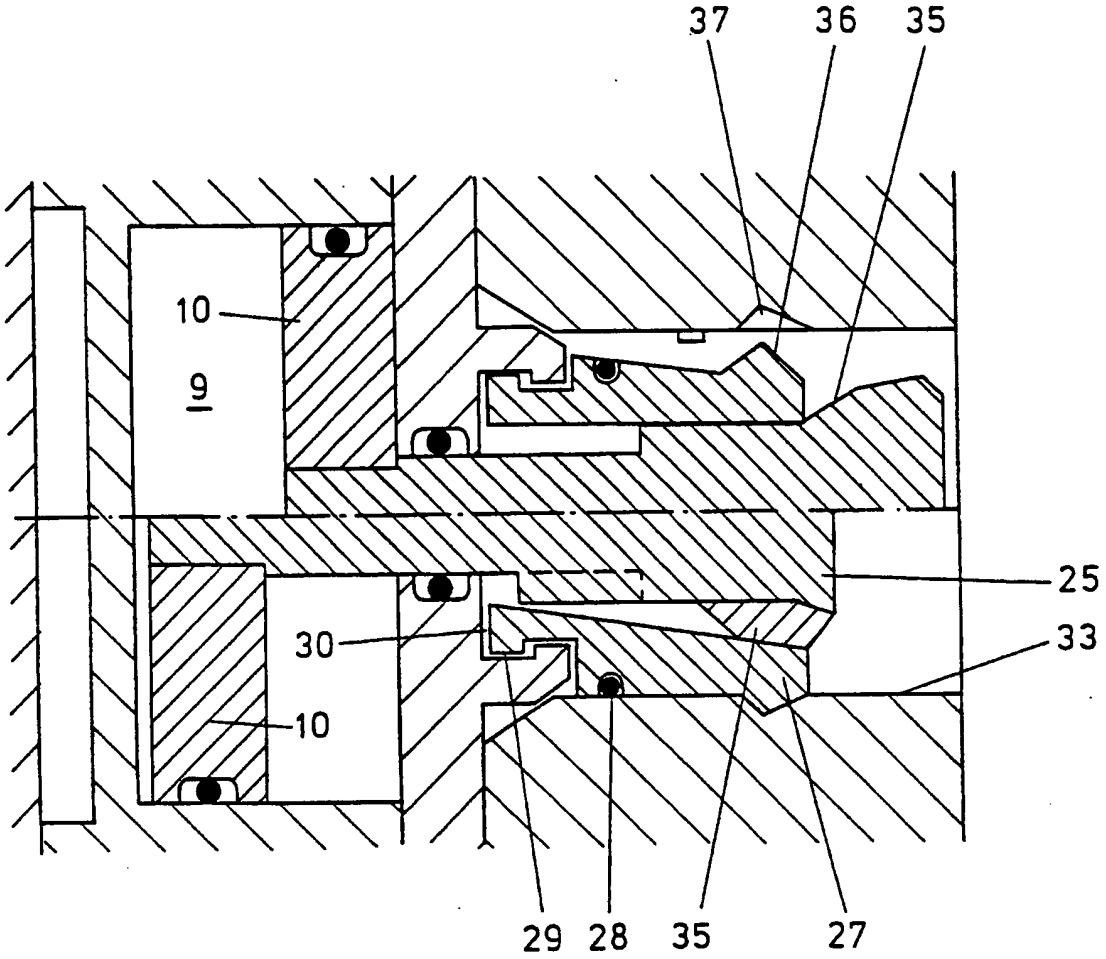

FIG. 4

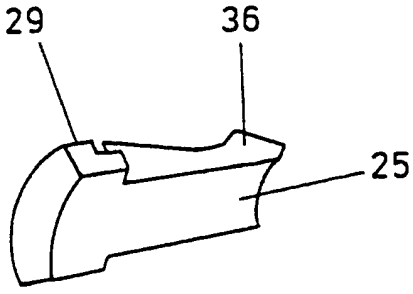

FIG. 5

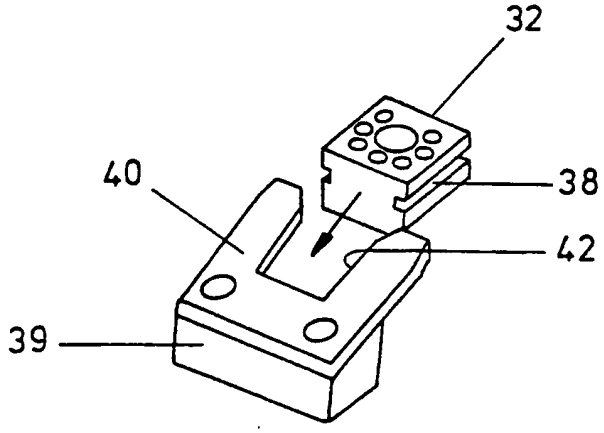

FIG. 6

INTERNATIONAL SEARCH REPORT

Intern: al Application No
PCT/GB 95/01168

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B25J15/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B25J

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 561 816 (DINGESS) 31 December 1985 see column 4, line 33 - line 56 see column 5, line 52 - column 6, line 46 see column 7, line 49 - column 8, line 1	1
Y	---	2
Y	EP,A,0 043 153 (COMAU) 6 January 1982 see page 10, line 5 - page 11, line 4 see page 10, line 19 - page 11, line 15	2
X	---	1
	WO,A,87 04653 (BOSCH) 13 August 1987 see page 4, line 6 - page 5, line 26; claim 1	
A	---	3
	DE,U,86 29 693 (MERTENS) 12 February 1987 see claim 7	

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16 August 1995	16. 10. 95

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US-A-4561816	31-12-85	NONE		
EP-A-43153	06-01-82	JP-A-	57039082	04-03-82
		SU-A-	1058492	30-11-83
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WO-A-8704653	13-08-87	DE-A-	3613980	06-08-87
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DE-U-8629693	12-02-87	DE-A-	3731884	19-05-88